

# The Hubble Space Telescope Wide Field Camera 3 (WFC3)



## History & Overview

In June 1997, NASA made the decision to extend the end of the HST mission from 2005 until 2010. As a result, the age of the instruments on board the HST became a consideration. After careful study, NASA decided to ensure the imaging capabilities of the HST by replacing the Wide Field Planetary Camera 2 (WFPC2), with a low-cost facility instrument, the Wide Field Camera 3 (WFC3).

## Scientific Goals

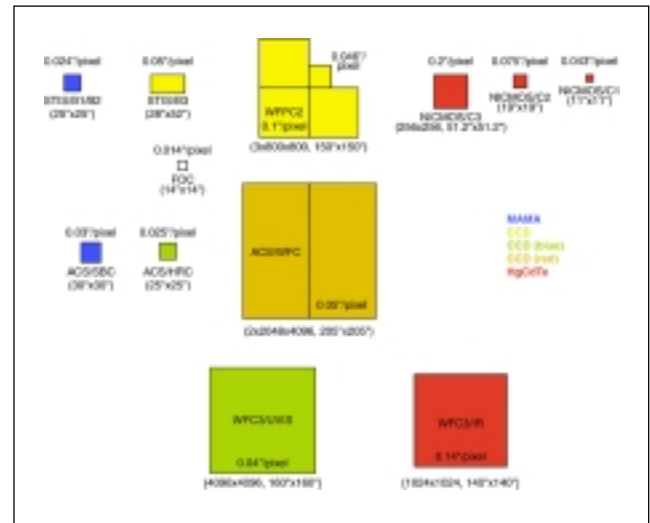
The WFC3 was originally conceived as a way to provide a backup imaging capability for HST during the latter part of its mission. During the study phase for the instrument, it became very clear that there are some key scientific questions that we can easily tailor the instrument to address.

A main theme for WFC3 science is the ability to do wide-field, panchromatic imaging. With its wide-field IR channel, the WFC3 will explore the IR universe that has been revealed by the NICMOS deep field observations. With an appropriate set of narrow-band filters, both of its wide-field and low-noise channels are well tailored for probing the astrophysics of the interstellar medium.

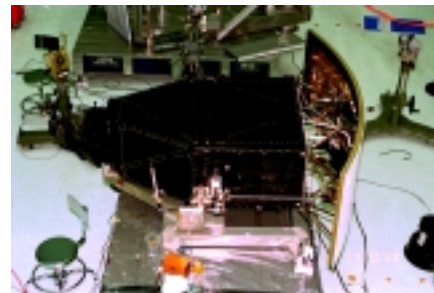
For example, these features can be brought to bear to provide an unprecedented panchromatic view of galaxy evolution. In order to study the controlling mechanisms of star formation in galaxies and to learn how to interpret the flood of tantalizing data on very distant galaxies, often observed in the restframe UV, we require high quality UV-optical-IR imaging of nearby objects for which good correlative radio, infrared, and X-ray data are available.

WFC3 is uniquely capable of providing such imaging. The UV conveys the most information about the history of star formation over the past 500 Myr and allows direct detection of the massive stars responsible for most ionization, photodissociation, kinetic energy input, and element synthesis in galaxies. The IR traces the mature stellar population and most of the stellar mass and probes dusty star forming regions.

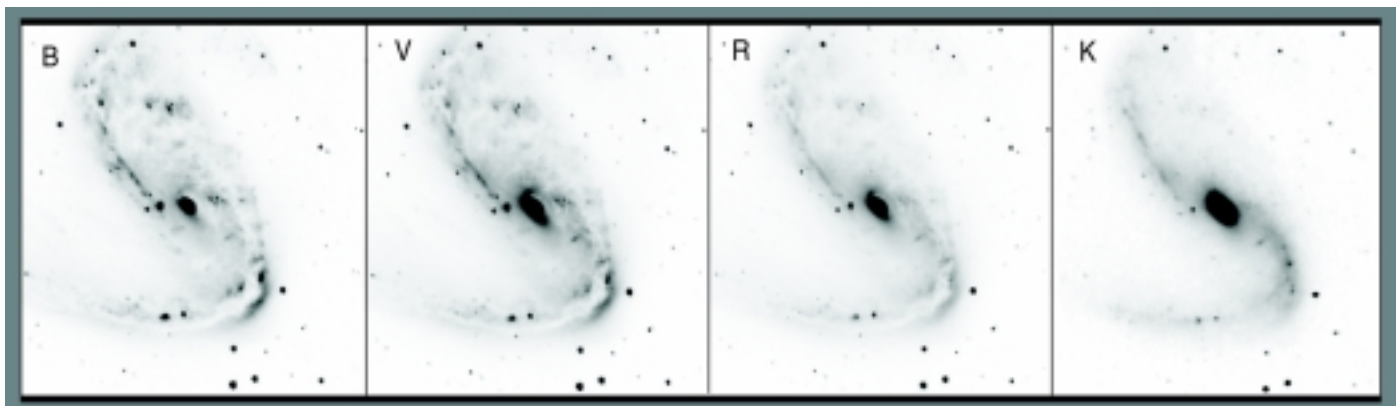
The panchromatic coverage of WFC3 from the mid-UV at 2000 Å to the near-IR at 18000 Å, with high resolution over a wide field, therefore offers powerful insights into galaxy evolution.



The above illustration shows the relative fields-of-view for all the HST imaging instruments. The spectral range covered by the particular mode or channel is shown schematically by its horizontal location (far left is 100 nm UV, far right is 2.5 μm IR). The WFC3 IR channel field-of-view is currently under review. The 140 arcsec field shown, is one possible configuration.



The WF/PC(1) being de-integrated at NASA/GSFC in early 1999.



Anatomy of galaxy NGC 2442, from B-band through K-band.

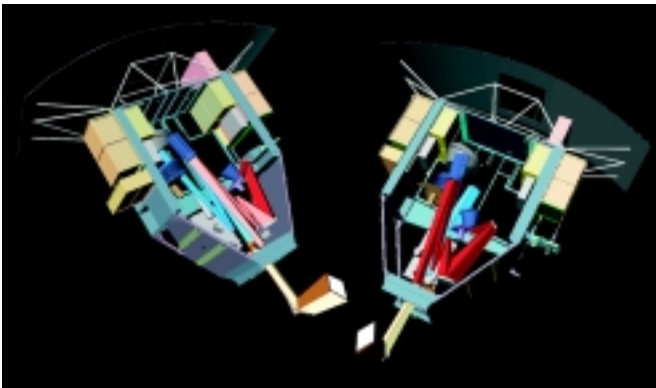
Instrument Configuration

The WFC3 is configured as a two channel instrument. The incoming beam from the HST is directed into the instrument using a pickoff mirror. It is then corrected for the spherical aberration in the HST primary using a two element system to reimage and correct the pupil. The corrected beam is then sent to either a near-UV/visible UVIS channel or an IR channel.

Instrument Performance

|                | UVIS                             | IR             |                    |
|----------------|----------------------------------|----------------|--------------------|
| Format         | 4K x 4K<br>UV or<br>Blue Coating | 1K x 1K        | pixels             |
| Field Size     | 160 x 160                        | 140 x 140      | arcsec             |
| Pixel Size     | 39                               | 140            | mas                |
| Spectral Range | 200 to 1000                      | 850 to 1800 nm |                    |
| Throughput     | See Chart                        | See Chart      |                    |
| Dark Current   | < 0.003                          | < 0.4          | e-/pix/sec         |
| Readout Noise  | < 4                              | < 15           | e-/pix/<br>readout |
| Operating Temp | -100                             | -120           | C                  |
| Filters        | 48                               | 10             |                    |

This table summarizes the WFC3 performance parameters.



This figure shows two views of the conceptual layout of the WFC3. The red beam represents the IR channel. The blue beam represents the near-UV/visible UVIS channel.

New Technology

The WFC3 is a fourth-generation instrument for HST. It is built on a low-cost paradigm that maximizes the reuse of existing designs and parts. In order to improve its scientific productivity, we have incorporated new detector technologies wherever possible.

The UVIS channel uses a large format, 4K x 4K CCD design. This is similar to the configuration used by the HST Advanced Camera for Surveys, scheduled for deployment in late 2000. The additional time available for WFC3 allows us to pursue advanced coatings for the backside-illuminated WFC3 CCDs. These coatings can provide greater than 50% quantum efficiency (QE) at 200 nm to improve near-UV capabilities.

The near-IR channel uses state-of-the-art Mercury-Cadmium Telluride (MCT) focal plane arrays from the Rockwell Science Center. These detectors are a more advanced version of the ones in the HST Near-Infrared Camera and Multi-Object Spectrometer (NICMOS) instrument, providing a factor of 16 increase in the number of pixels, and over a factor of 2 increase in quantum efficiency. Another innovation in the MCT detectors is our tailoring the long-wavelength cutoff to a shorter wavelength than is usual. This cutoff (at 1.9 um) allows the detector to operate at relatively warm temperatures (~ -120C) with acceptable dark current. This capability allows the instrument to use simple, low-cost, thermoelectric cooling systems instead of the cryogenics or mechanical cryocoolers that are typical in other IR instruments.

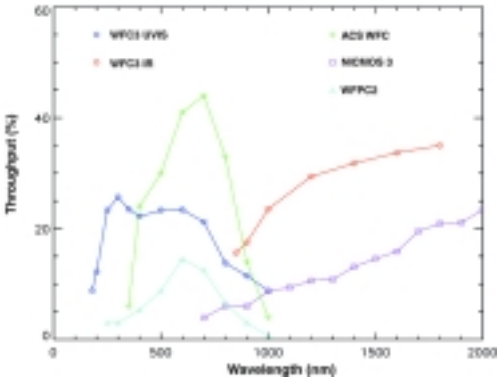
Scientific Oversight Committee

The development of WFC3 is guided by a Scientific Oversight Committee (SOC) which is chartered to provide broad scientific advice to the WFC3 project. It will define the key scientific objectives achievable by the WFC3, within the instrument’s main programmatic and technical constraints.

For further information, feedback, and contacts,  
please visit the WFC3 Web Site at:  
<http://wfc3.gsfc.nasa.gov>

WFC3 Filter Workshop, July 14, 1999  
Baltimore, MD - Information online.

The expected total instrument throughput as a function of wavelength is shown in the following chart. The wide wavelength coverage at high efficiency is made possible by the dual-channel design using two detector technologies.



The optical purity of the instrument will support diffraction-limited imaging through 300 nm for the CCD channel, and 1000 nm for the IR channel. This allows the instrument to exploit another unique HST capability, that of a well-defined and uniform point-spread-function over the entire field-of-view.

